Rec'd PCT/PTO 01 DEC 2004

PCT / IB 0 3 / 0 23 6 7

0 5 JUN 2003

Europäisches Patentamt	European Patent Office	Office européen des brevets

REC'D 25 JUN 2003

WIPO PCT

Bescheinigung / Certificate / Attestation

Die angehefteten Unterlagen stimmen mit der ursprünglich eingereichten Fassung der auf dem nächsten Blatt bezeichneten europäischen Patentanmeldung überein.

The attached documents are exact copies of the European patent application described on the following page, as originally filed.

Les documents fixés à cette attestation sont conformes à la version initialement déposée de la demande de brevet européen spécifiée à la page suivante.

Patentanmeldung Nr. / Patent application No. / Demande de brevet n°

02077211.7

PRIORITY DOCUMENT
SUBMITTED OR TRANSMITTED IN COMPLIANCE WITH RULE 17.1(a) OR (b)

Der Präsident des Europäischen Patentamts;
Im Auftrag

For the President of the European Patent Office

Le Président de l'Office européen des brevets
p.o.

R C van Dijk

DEN HAAG, DEN
THE HAGUE, 25/03/03
LA HAYE, LE

EPA/EPO/OEB Form 1014 - 02.91

Europäisches Patentamt

European Patent Office

Office européen des brevets

Blatt 2 der Bescheinigung
Sheet 2 of the certificate
Page 2 de l'attestation

Anmeldung Nr.:
Application no.: 02077211.7
Demande n°:

Anmeldetag:
Date of filing: 06/06/02
Date de dépôt:

Anmelder:
Applicant(s):
Demandeur(s):
Koninklijke Philips Electronics N.V.
5621 BA Eindhoven
NETHERLANDS

Bezeichnung der Erfindung:
Title of the invention:
Titre de l'invention:
Low-pressure mercury vapor discharge lamp

In Anspruch genommene Prioriät(en) / Priority(ies) claimed / Priorité(s) revendiquée(s)

Staat:
State:
Pays:

Tag:
Date:
Date:

Aktenzeichen:
File no.
Numéro de dépôt:

Internationale Patentklassifikation:
International Patent classification:
Classification internationale des brevets:
/

Am Anmeldetag benannte Vertragstaaten:
Contracting states designated at date of filing: AT/BE/CH/CY/DE/DK/ES/FI/FR/GB/GR/IE/IT/LI/LU/MC/NL/PT/SE/TR
Etats contractants désignés lors du depôt:

Bemerkungen:
Remarks:
Remarques:

EPO - DG 1
-6. 06. 2002
(54)

Low-pressure mercury vapor discharge lamp

The invention relates to a low-pressure mercury vapor discharge lamp comprising a light-transmitting discharge vessel,

the discharge vessel enclosing, in a gastight manner, a discharge space provided with an inert gas mixture and with mercury,

a first portion of the discharge vessel being provided with a first electrode arranged in the discharge space and with a luminescent layer,

while said first portion, in operation, radiates light in a first range of the electromagnetic spectrum from 100 to 1000 nm,

a second portion of the discharge vessel being provided with a second electrode arranged in the discharge space,

while said second portion, in operation, radiates light in a second range of the electromagnetic spectrum from 100 to 1000 nm, said second range being different from the first range.

The invention also relates to a compact fluorescent lamp.

In mercury vapor discharge lamps, mercury constitutes the primary component for the (efficient) generation of ultraviolet (UV) light. A luminescent layer comprising a luminescent material (for example, a fluorescent powder) may be present on an inner wall of (a portion of) the discharge vessel to convert UV to other wavelengths, for example, to UV-B and UV-A for tanning purposes (sun panel lamps) or to visible radiation for general illumination purposes. Such discharge lamps are therefore also referred to as fluorescent lamps. The discharge vessel of low-pressure mercury vapor discharge lamps is usually circular and comprises both elongate and compact embodiments. Generally, the tubular discharge vessel of compact fluorescence lamps comprises a collection of relatively short straight parts having a relatively small diameter, which straight parts are connected together by means of bridge parts or via bent parts. Compact fluorescent lamps are usually provided with an (integrated) lamp cap.

In the description and claims of the current invention, the designation "nominal operation" is used to refer to operating conditions where the mercury-vapor pressure is such that the radiation output of the lamp is at least 80% of that during maximum

light output at nominal operation, i.e. under operating conditions where the mercury-vapor pressure is optimal. In addition, in the description and claims, the "initial radiation output" is defined as the radiation output of the discharge lamp 1 second after switching on the discharge lamp, and the "run-up time" is defined as the time needed by the discharge lamp to reach a radiation output of 80% of that during optimum operation.

Low-pressure mercury-vapor discharge lamps are known comprising an amalgam. Such discharge lamps have a comparatively low mercury-vapor pressure at room temperature. As a result, amalgam-containing discharge lamps have the disadvantage that also the initial radiation output is comparatively low when a customary power supply is used to operate said lamp. In addition, the run-up time is comparatively long because the mercury-vapor pressure increases only slowly after switching on the lamp.

Apart from amalgam-containing discharge lamps, low-pressure mercury-vapor discharge lamps are known which comprise both a (main) amalgam and a so-called auxiliary amalgam. If the auxiliary amalgam comprises sufficient mercury, then the lamp has a relatively short run-up time. Immediately after the lamp has been switched on, i.e. during preheating the electrodes, the auxiliary amalgam is heated by the electrode so that it relatively rapidly dispenses a substantial part of the mercury that it contains. In this respect, it is desirable that, prior to being switched on, the lamp has been idle for a sufficiently long time to allow the auxiliary amalgam to take up sufficient mercury. If the lamp has been idle for a comparatively short period of time, the reduction of the run-up time is only small. In addition, in that case the initial radiation output is (even) lower than that of a lamp comprising only a main amalgam, which can be attributed to the fact that a comparatively low mercury-vapor pressure is adjusted in the discharge space by the auxiliary amalgam. An additional problem encountered with comparatively long lamps is that it takes comparatively much time for the mercury liberated by the auxiliary amalgam to spread throughout the discharge vessel, so that after switching on such lamps, they demonstrate a comparatively bright zone near the auxiliary amalgam and a comparatively dark zone at a greater distance from the auxiliary amalgam, which zones disappear after a few minutes. An alternative version of the low-pressure mercury vapor discharge lamp is the so-called "cold-spot" mercury discharge lamp wherein the mercury pressure is controlled by a so-called cold-spot temperature located somewhere in the discharge vessel.

In addition, low-pressure mercury-vapor discharge lamps are known which are not provided with an amalgam and contain only free mercury. These lamps also referred to [illegible]

temperature and hence the initial radiation output are relatively high as compared to amalgam-containing discharge lamps and as compared to discharge lamps comprising a (main) amalgam and an auxiliary amalgam. In addition, the run-up time is comparatively short. After having been switched on, comparatively long lamps of this type also demonstrate a substantially constant brightness over substantially the whole length, which can be attributed to the fact that the vapor pressure (at room temperature) is sufficiently high at the time of switching on these lamps.

A low-pressure mercury vapor discharge lamp of the type described in the opening paragraph is known from EPA 0 658 921. The known low-pressure mercury vapor discharge lamp comprises two interconnected lamp vessels, a first portion provided with a first electrode and with a first luminescent layer and a second portion provided with a second electrode and with a second luminescent layer. By applying a third electrode and supplying high-frequency currents of changing polarity, the color point is made adjustable. In the known discharge lamp, the high-frequency current flows through the first portion of the discharge lamp during a first time interval via the first electrode and the third electrode and through the second portion of the discharge lamp during a second time interval via the second electrode and the third electrode. The color point of the light irradiated by the known discharge lamp is made adjustable by adjusting the ratio of a first time interval and the second time interval. A drawback of the use of the known low-pressure mercury vapor discharge lamp is that an additional electrode, high-frequency currents as well as advanced switching and control means are required to provide an adjustable color point.

It is an object of the invention to eliminate the above disadvantage wholly or partly. In particular, it is an object of the invention to provide a low-pressure mercury vapor discharge lamp emitting light in variable ranges of the electromagnetic spectrum whose construction is relatively simple. According to the measure of the invention, a low-pressure mercury vapor discharge lamp of the kind mentioned in the opening paragraph is for this purpose characterized in that the low-pressure mercury vapor discharge lamp comprises current supply conductors for receiving a DC current, and the discharge space contains only two electrodes.

A discharge vessel of a low-pressure mercury vapor discharge lamp according the invention with two electrodes and operating under DC conditions, has a gradient in mercury density over the length of the discharge space. Due to this gradient in mercury density, e.g. the first portion of the discharge vessel contains more mercury (ions) than the second portion. The light output of the first portion of the discharge vessel is enhanced and the light output of the second portion is relatively low. In this situation, the light emitted by the low-pressure mercury vapor discharge lamp according to the invention largely corresponds to the electromagnetic spectrum emitted by the first portion. If the polarity of the DC current is reversed, the other electrode becomes the cathode and the gradient in mercury density (gradually) reverses, thereby enhancing the light output of the second portion of the discharge vessel at the cost of the light output of the first portion which is lowered. In this situation, the light emitted by the low-pressure mercury vapor discharge lamp according to the invention largely corresponds to the electromagnetic spectrum emitted by the second portion. By regulating the level of the DC current in the discharge vessel, the light emitted by the low-pressure mercury vapor discharge lamp according to the invention can be a mix between the electromagnetic spectrum emitted by the first portion and the second portion of the discharge vessel. In this manner, a low-pressure mercury vapor discharge lamp with an adjustable light emission spectrum is realized comprising only two electrodes.

In the description and claims of the current invention, the designation “light radiated in a range of the electromagnetic spectrum from 100 to 1000 nm” is used to refer to light emitted in the UV-C, UV-B, UV-A and/or in the visible range. By way of example, the first portion of the discharge vessel, in operation, radiates visible light of a first color temperature (by using a first mix of luminescent materials) and the second portion radiates light of a second color temperature (by using a second mix of luminescent materials). In another example, the first portion of the discharge vessel, in operation, radiates visible light and the second portion radiates UV-C, UV-B and/or UV-A. In yet another example, the first portion of the discharge vessel, in operation, radiates UV-A and the second portion radiates UV-B. The person skilled in the art can conceive additional variations within the scope of the invention.

A preferred embodiment of the low-pressure mercury vapor discharge lamp according to the invention is characterized in that an amalgam is provided in the discharge vessel. The (temperature of the) amalgam sets the level of the mercury pressure in the [illegible]

lowering the mercury density, the light output of the portion of the discharge vessel with the first range of the electromagnetic spectrum is lowered in favor of the light output of the other portion with the second range of the electromagnetic spectrum. If both portions of the discharge vessel are provided with different mixes of luminescent materials, the average color temperature of the discharge vessel may shift to lower temperatures as a consequence of the decreasing DC current.

The color temperature of the known low-pressure mercury vapor discharge lamps shifts to higher temperatures upon lowering the electrical power through the discharge vessel. This is, generally speaking, an undesirable property of a low-pressure mercury vapor discharge lamp. For incandescent lamps the color temperature lowers upon dimming the lamp. According to the measure of the invention, the color temperature of low-pressure mercury vapor discharge lamp also shifts to lower temperatures upon dimming of the discharge lamp. This is a favorable property of the low-pressure mercury vapor discharge lamp according to the invention.

Preferably, the amalgam is provided in the region between the first and second portion of the discharge vessel. This has the advantage that both portions of the discharge vessel profit approximately equally from the presence of the amalgam independent of the polarity of the DC current. Due to this intermediate position of the amalgam, the mercury pressure above the amalgam is practically constant and independent of the DC polarity, thereby enabling a minimal time between the change of spectral emission of the first portion and the second portion.

A preferred embodiment of the low-pressure mercury vapor discharge lamp according to the invention is characterized in that the amalgam is provided in the region of the electrode of the portion of the discharge vessel with the lowest color temperature.

In another preferred embodiment of the low-pressure mercury vapor discharge lamp according to the invention the amalgam is provided in the region of the first electrode and a further amalgam is provided in the region of the second electrode. This embodiment has the advantage that irrespective of the polarity of the DC current an amalgam is available in the vicinity of the first or second electrode. Depending on the polarity of the DC current, the mercury (ions) migrate towards the electrode which functions as the cathode. Whether the first or the second electrode acts as the cathode, an amalgam for regulating the mercury pressure is available in the vicinity of the cathode, thereby ensuring a more reliable operation of the low-pressure mercury vapor discharge lamp.

A preferred embodiment of the low-pressure mercury vapor discharge lamp according to the invention is characterized in that a wall of the second portion of the discharge vessel is made from a glass which is transmissible to UV. UV-transmissive glass is used e.g. for purposes of disinfection in e.g. hospitals or clinical laboratories. The principle of adjusting the electromagnetic spectrum of the discharge vessel a as described above can be employed by switching the discharge lamp from one function (e.g. general lighting during daytime) to the other function (e.g. disinfection during nighttime). A great advantage here is that two functions for which at the moment two discharge lamps, including two ballasts and fixtures are required are combined in a single lamp including one ballast and one fixture. This is particularly advantageous in situations where there is limited space available and/or additional weight has to be avoided. For example in airplanes such a low-pressure mercury vapor discharge lamp according to the invention can be successfully employed: when the passengers are in the plane, the discharge lamp is used for general lighting purposes and when the passengers are absent the discharge lamp is switched to emit UV light.

An alternatively preferred embodiment of the low-pressure mercury vapor discharge lamp according to the invention is characterized in that the second portion of the discharge vessel is provided with a further luminescent layer. In operation, the further luminescent layer in the second portion emits light of a color temperature that is different from the light emitted by the luminescent layer in the first portion of the discharge lamp. By properly selecting the color temperature of the light emitted by the first and second portion a whole range of color temperatures is encompassed by the low-pressure mercury vapor discharge lamp according to the invention.

In another preferred embodiment of the low-pressure mercury vapor discharge lamp according to the invention the low-pressure mercury vapor discharge lamp is adapted to receive an AC current. By operating the lamp on an AC current both the first and the second portion of the discharge lamp have the optimal mercury density and emit approximately the same amount of light and both ranges of the electromagnetic spectrum, and preferably, an average color temperature is achieved. By adjusting the level and/or the polarity of the DC current light emission by the first portion can be given preference over that of the second portion of the discharge vessel. Combining DC and AC operational conditions for the discharge lamp gives a full range of possibilities for adjusting the emission spectrum of the low-pressure mercury vapor discharge lamp according to the invention.

preferred embodiment of the low-pressure mercury vapor discharge lamp

approximately 0.2 mg mercury. There is a tendency in governmental regulations to prescribe a maximum amount of mercury present in a low-pressure mercury vapor discharge lamp that if the discharge lamp comprises less than said prescribed amount allows the user to dispose of the lamp without environmental restrictions. If a mercury discharge lamp contains less than 0.2 mg of mercury such requirements are largely fulfilled. Preferably, the discharge vessel contains less than 0.05 mg mercury.

These and other aspects of the invention are apparent from and will be elucidated with reference to the embodiments described hereinafter.

In the drawings:

Figure 1A is a cross-sectional view of an embodiment of a compact fluorescent lamp comprising a low-pressure mercury-vapor discharge lamp in accordance with the invention; and

Figure 1B is a cross-sectional view of a detail of the low-pressure mercury-vapor discharge lamp shown in Figure 1A;

The Figures are purely diagrammatic and not drawn to scale. Particularly for clarity, some dimensions are exaggerated strongly. Similar components in the Figures are denoted as much as possible by the same reference numerals.

Figure 1 shows a compact fluorescent lamp comprising a low-pressure mercury-vapor discharge lamp. Said low-pressure mercury-vapor discharge lamp is provided with a radiation-transmitting discharge vessel 1 which encloses a discharge space 3 having a volume of approximately 10 cm^3 to 100 cm^3 in a gastight manner. The discharge vessel 1 is a glass tube which is at least substantially circular in cross-section and which has an (effective) inner diameter of approximately 10 mm to 25 mm. The discharge vessel 1 comprises a first portion 11 and a second portion 21. In the example of Figure 1 the first and the second portion 11, 21 are interconnected via a channel or bridge 20. In an alternative embodiment, the discharge vessel is folded and e.g. comprises bent parts. A first portion 11 of the discharge vessel 1 is provided with a first electrode 12 arranged in the discharge space 3. At an inner wall of the first portion 11 of the discharge vessel 1 a luminescent layer 16 is provided. In operation, the first portion 11 radiates light in a first range of the electromagnetic spectrum from 100 to 1000 nm. By way of example the first range may correspond to a first color temperature, the first color temperature being e.g. 2700 K. A

second portion 21 of the discharge vessel 1 is provided with a second electrode 22 arranged in the discharge space 3. In the example of Figure 1, a further luminescent layer 26 is provided at an inner wall of the second portion 21 of the discharge vessel 1. In operation, the second portion 21 radiates light in a second range of the electromagnetic spectrum from 100 to 1000 nm. By way of example the second range may correspond to a second color temperature, the second color temperature being e.g. 6500 K.. In an alternative embodiment, the further luminescent layer is omitted. In that case, the wall of the second portion of the discharge vessel, preferably, is made from a glass which is transmissible to UV, said second portion emitting e.g. UV-C. In a further alternative embodiment one of the first portion emits UV-A and the second portion emits UV-B. The skilled person easily conceives additional variations of emission spectra emitted by the first and second portion of the discharge vessel of the low-pressure mercury vapor discharge lamp within the scope of the invention.

The electrode pair 12; 22 generally is a winding of tungsten covered with an electron-emitting substance, in this case a mixture of barium oxide, calcium oxide and strontium oxide. Each of the electrodes 12; 22 is supported by a (narrowed) end portion of the discharge vessel 1. Current supply conductors 12A, 12B; 22A, 22B extend from the electrode pair 12; 22 through the end portions of the discharge vessel 1 where they issue to the exterior. The current supply conductors 12A, 12B; 22A, 22B are connected to an (electronic) power supply. For the application of DC currents to the electrodes, in principle, it is sufficient if either the current supply conductors 12A and 22A or the current supply conductors 12B and 22B. If the low-pressure mercury vapor discharge lamp operates under DC operation only, half of the number of current supply conductors can be omitted.

The discharge vessel 10 of the low-pressure mercury-vapor discharge lamp can be surrounded by a light-transmitting envelope (not shown in Figure 1), which is secured to the lamp housing 70. The light-transmitting envelope generally has a matt appearance.

In the example of Figure 1, mercury is not only present in the discharge space 3 but also in an amalgam 4 provided in the region between the first and the second portion 11, 21 of the discharge vessel 1. In an alternative embodiment, the amalgam is provided in the region of the electrode of the portion of the discharge vessel with the lowest color temperature.

In a further alternative embodiment, the amalgam is provided in the region of the first electrode and a further amalgam is provided in the region of the second electrode. In operation, the amalgam 4 is in communication with the discharge space 3. In an alternative

embodiment, the discharge vessel is further provided with a so-called auxiliary amalgam (not shown in Figure 1).

Figure 2A shows schematically, the mercury density μHg as a function of the position l_{dv} in the discharge vessel 1. Figure 2B shows schematically the corresponding light output φ of the discharge vessel 1 as a function of the position l_{dv} in the discharge vessel. When the discharge lamp is operated on a DC current (with an electronic circuit), the mercury ions will drift towards the cathode side of the lamp. This leads to a gradient in the mercury distribution and accordingly to a gradient in the light output as can be seen in Figures 2A and 2B. When electrode 12 is the cathode (indicated by "12–" in Figure 2A), the light output will have the emission spectrum, e.g. a first color temperature, corresponding to the first portion 12 of the discharge vessel 1. When the second electrode 22 is made cathode (indicated by "22–" in Figure 2A), the light will have the emission spectrum, e.g. a second color temperature, according to the second portion 22 of the discharge vessel 1. By regulating the DC level of the current, the emission spectrum, e.g. the color temperature, of the discharge lamp is made adjustable. Since the amalgam 4 is positioned in the middle of the discharge vessel, the mercury pressure above the amalgam is constant and independent of the DC polarity. This ensures a minimal time between the change of color.

By decreasing the level of the DC current, the power in the discharge vessel 1 decreases and therefore the temperature of the amalgam 4 lowers and the total mercury density lowers. This implied that the light output of both the first and the second portion 11; 21 shifts to the left over the light output versus mercury density curve. This results in a lower light output for the portion with the higher color temperature and an increased light output for the portion with the lower color temperature. By dimming, the color temperature shifts to lower temperatures, as is the case in normal incandescent lamps. In an alternative embodiment a so-called cold spot in stead of an amalgam is used.

Figure 2A also shows the situation in which the low-pressure mercury vapor discharge lamp operates under AC current conditions. In this situation, the light from both portions mix to a color temperature which lies approximately in between the first and the second color temperature.

It will be evident that many variations within the scope of the invention can be conceived by those skilled in the art.

The scope of the invention is not limited to the embodiments. The invention resides in each new characteristic feature and each combination of novel characteristic features. Any reference signs do not limit the scope of the claims. The word "comprising"

does not exclude the presence of other elements or steps than those listed in a claim. Use of the word "a" or "an" preceding an element does not exclude the presence of a plurality of such elements.

CLAIMS:

1. A low-pressure mercury vapor discharge lamp comprising a light-transmitting discharge vessel,

the discharge vessel enclosing, in a gastight manner, a discharge space provided with an inert gas mixture and with mercury,

a first portion of the discharge vessel being provided with a first electrode arranged in the discharge space and with a luminescent layer,

while said first portion, in operation, radiates light in a first range of the electromagnetic spectrum from 100 to 1000 nm,

a second portion of the discharge vessel being provided with a second electrode arranged in the discharge space,

while said second portion, in operation, radiates light in a second range of the electromagnetic spectrum from 100 to 1000 nm, said second range being different from the first range,

characterized in that

the low-pressure mercury vapor discharge lamp comprises current supply conductors for receiving a DC current, and

the discharge space contains only two electrodes.

2. A low-pressure mercury vapor discharge lamp as claimed in claim 1, characterized in that an amalgam is provided in the discharge vessel.

3. A low-pressure mercury vapor discharge lamp as claimed in claim 2, characterized in that the amalgam is provided in the region between the first and second portion of the discharge vessel.

4. A low-pressure mercury vapor discharge lamp as claimed in claim 2, characterized in that the amalgam is provided in the region of the electrode of the portion of the discharge vessel with the lowest color temperature.

5. A low-pressure mercury vapor discharge lamp as claimed in claim 2 or 4, characterized in that the amalgam is provided in the region of the first electrode and a further amalgam is provided in the region of the second electrode.

6. A low-pressure mercury vapor discharge lamp as claimed in claim 1, characterized in that a cold spot is provided in the discharge vessel.

7. A low-pressure mercury vapor discharge lamp as claimed in claim 6, characterized in that the cold spot is provided in the region between the first and second portion of the discharge vessel.

8. A low-pressure mercury vapor discharge lamp as claimed in claim 1 or 2, characterized in that a wall of the second portion of the discharge vessel is made from a glass which is transmissible to UV.

9. A low-pressure mercury vapor discharge lamp as claimed in claim 1 or 2, characterized in that the second portion of the discharge vessel is provided with a further luminescent layer.

10. A low-pressure mercury vapor discharge lamp as claimed in claim 1 or 2, characterized in that the low-pressure mercury vapor discharge lamp is adapted to receive an AC current.

11. A low-pressure mercury vapor discharge lamp as claimed in claim 1, 2, 3 or 4, characterized in that the discharge vessel contains less than 0.2 mg mercury.

12. A compact fluorescent lamp comprising a low-pressure mercury-vapor discharge lamp as claimed in claim 1 or 2, characterized in that a lamp housing is attached to the discharge vessel of the low-pressure mercury-vapor discharge lamp, which lamp housing is provided with a lamp cap.

13. A compact fluorescent lamp as claimed in claim 12, characterized in that the [illegible]

ABSTRACT:

Low-pressure mercury vapor discharge lamp has a light-transmitting discharge vessel (1). The discharge vessel encloses, in a gastight manner, a discharge space (3) provided with an inert gas mixture and with mercury. A first portion (11) of the discharge vessel is provided with a first electrode (12) and with a luminescent layer (16). Said first portion radiates light in a first range of the electromagnetic spectrum from 100 to 1000 nm. A second portion (21) of the discharge vessel is provided with a second electrode (22). Said second portion, in operation, radiates light in a second range of the electromagnetic spectrum from 100 to 1000 nm, said second range being different from the first range. According to the invention, the low-pressure mercury vapor discharge lamp comprises current supply conductors (12A, 12B; 22A, 22B) for receiving a DC current, and the discharge space contains only two electrodes (12, 22).

Fig. 1

PHNL020457

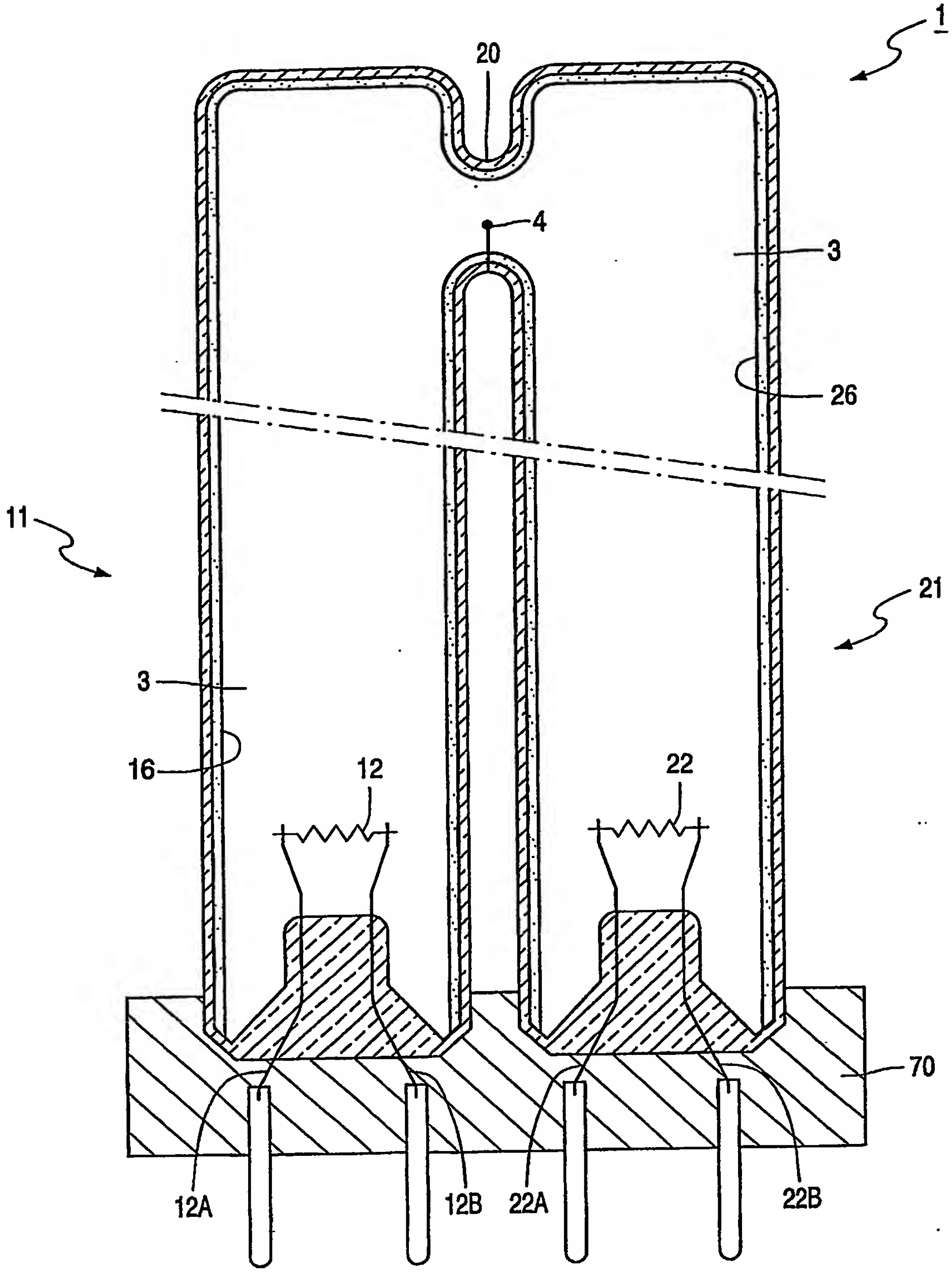

FIG. 1

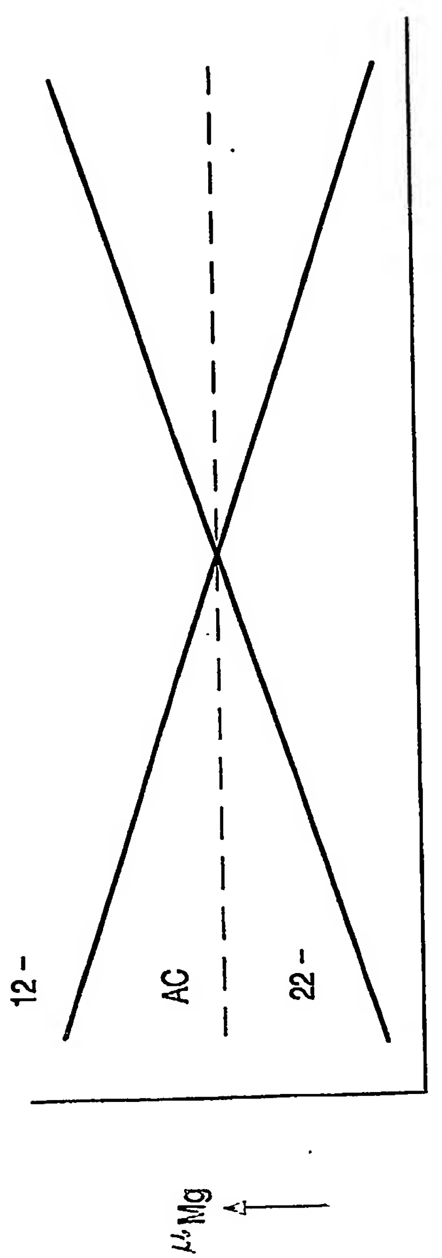

FIG. 2A

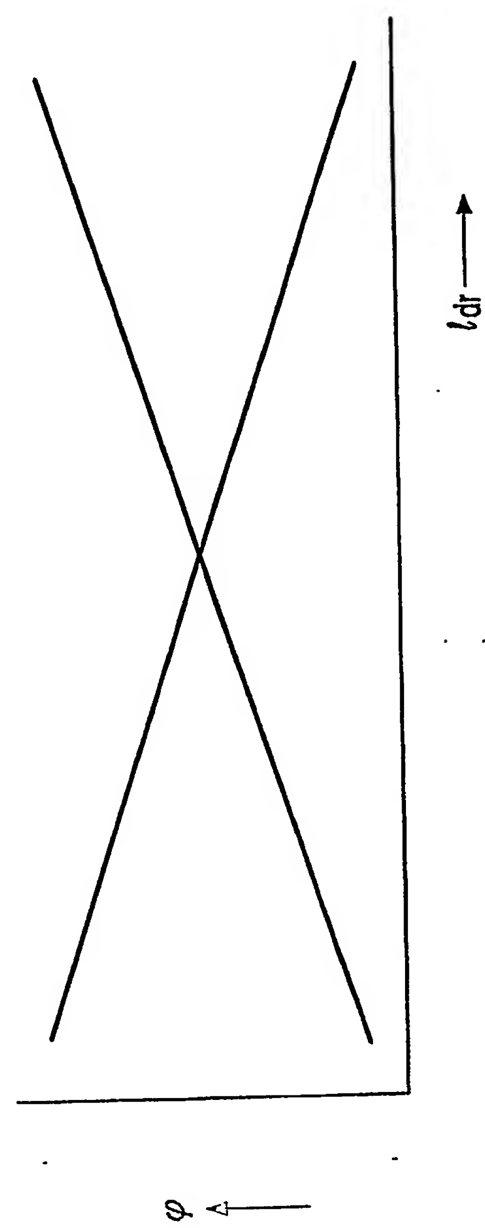

FIG. 2B